50 mg/100 ml as the ruminant begins to derive energy from the metabolism of absorbed volatile fatty acids.

Therefore, although there may be no definite correlation between the ruminant state and the reduction of 'true' sleep, since long periods of somnolence do occur there may be some causal relationship between paradoxical sleep and the peculiar metabolism of adult ruminants.

Paradoxical sleep in man is sometimes regarded as a necessary accompaniment of dreaming and, of course, we are unable to ascertain whether this is so in animals. In the horse and ox it has been demonstrated that when recumbency is denied the amount of paradoxical sleep subsequently increases. It has also been suggested that paradoxical sleep may be a phase of restitution of biochemical elements in the nervous system. The position of ruminants which normally show very little paradoxical sleep weakens this argument although possibly some normal component of ruminant metabolism may provide the restorative phase. The increase of paradoxical sleep in fatigued cows and horses adds weight to the idea that the paradoxical phase of sleep may be necessary for sustained activity of the nervous system.

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Sleep in Fishes [*Abstract*]

Observations on sleep in fishes have been made in nature and aquaria, and in relation to electrical rhythms in the nervous system. In coral reefs and atolls some species rest by day and emerge at night (e.g. squirrel-fishes and moray-eels); others, such as certain trigger-fishes, wrasses and parrot-fishes, are more active by day. Indeed, some parrot-fishes secrete around themselves a mucous 'sleeping-bag', which is said to reduce their scent to hunting moray-eels. Some nocturnal-resting coral fishes may be picked up by hand. In the deep ocean many mid-water (mesopelagic) fishes, particularly luminescent species, migrate towards the surface by night, where they feed, then begin the dive to their day-time levels just before sunrise. During daylight hours observers in deep submersibles have noted that lantern-fishes and other mesopelagic species are lethargic, some passively drifting with their main axes at acute angles to the horizontal plane.

In aquaria, as in nature, some fishes (e.g. red mullet and barracuda) change their colour pattern (to barred markings) when resting at night. Certain species rest in neutrally buoyant poses, while others, such as trigger-fishes and file-fishes, lie on one side on the bottom. During the day individuals of some species will even defend their sleeping place. Observations suggest that fishes need less sleep than other vertebrates.

Electrical brain patterns of cod resting in the dark show a dominant rhythm in the mid-brain of 8–13 Hz, which has features like the α rhythm of mammals. After arousal by light, the dominant rhythm changes to 18–32 Hz. Similar results were obtained from goldfish. Perhaps experiments will show that control of diurnal activities in sleeping teleosts involves the mid-brain and reticular formations in the diencephalon.

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Sleep in the Domestic Fowl

Several workers have described the EEG of the domestic fowl during wakefulness and sleep (Ookawa & Gotoh 1965, Peters *et al.* 1965, Klein *et al.* 1964); in general there is good agreement between their various results. The EEG of the alert hen comprises largely low-voltage (less than 50 μV) fast (up to 25 Hz) waves, which seem to be little modified by alarm or general disturbance. As the bird becomes drowsy, lower-frequency waves (3–4 Hz) of larger amplitude (over 100 μV) are interspersed in the basic pattern. In deeper sleep the slow waves predominate, but are punctuated each few minutes by several seconds of low-voltage, high-frequency activity which is generally equated to the pattern seen in paradoxical sleep in mammals. However, the neck muscles, at least, retain a